Financial Incentive Based Approaches for Weight Loss: A Randomized Trial

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PRELIMINARY COMMUNICATION

Financial Incentive–Based Approaches for Weight Loss
A Randomized Trial

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Context Identifying effective obesity treatment is both a clinical challenge and a public health priority due to the health consequences of obesity.

Objective To determine whether common decision errors identified by behavioral economists such as prospect theory, loss aversion, and regret could be used to design an effective weight loss intervention.

Design, Setting, and Participants Fifty-seven healthy participants aged 30-70 years with a body mass index of 30-40 were randomized to 3 weight loss plans: monthly weigh-ins, a lottery incentive program, or a deposit contract that allowed for participant matching, with a weight loss goal of 1 lb (0.45 kg) a week for 16 weeks. Participants were recruited May-August 2007 at the Philadelphia VA Medical Center in Pennsylvania and were followed up through June 2008.

Main Outcome Measures Weight loss after 16 weeks.

Results The incentive groups lost significantly more weight than the control group (mean, 3.9 lb). Compared with the control group, the lottery group lost a mean of 13.1 lb (95% confidence interval [CI] of the difference in means, 1.95-16.40; P=.02) and the deposit contract group lost a mean of 14.0 lb (95% CI of the difference in means, 3.69-16.43; P =.006). About half of those in both incentive groups met the 16-lb target weight loss: 47.4% (95% CI, 24.5%-71.1%) in the deposit contract group and 52.6% (95% CI, 28.9%-75.6%) in the lottery group, whereas 10.5% (95% CI, 1.3%- 33.1%; P=.01) in the control group met the 16-lb target. Although the net weight loss between enrollment in the study and at the end of 7 months was larger in the incentive groups (9.2 lb; t=1.21; 95% CI, –3.20 to 12.66; P=.23, in the lottery group and 6.2 lb; t=0.52; 95% CI, –5.17 to 8.75; P=.61 in the deposit contract group) than in the control group (4.4 lb), these differences were not statistically significant. However, incentive participants weighed significantly less at 7 months than at the study start (P=.01 for the lottery group; P=.03 for the deposit contract group) whereas controls did not.

Conclusions The use of economic incentives produced significant weight loss during the 16 weeks of intervention that was not fully sustained. The longer-term use of incentives should be evaluated.

Trial Registration clinicaltrials.gov Identifier: NCT00520611

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From 1960 to 2004, the rate of obesity in the United States increased from approximately 13% to 31%.[1] In 2004, 71% of US adults were overweight or obese according to standard definitions,[2] and at present obesity falls just behind smoking as a preventable cause of premature death.[3] New strategies are needed to help reduce the rate of obesity in the US population.

Although many variables contribute to the increase in obesity prevalence in the United States, behavioral economics has identified several patterns of behavior that help to explain why people engage in self-destructive behavior, including the tendency to put disproportionate emphasis on immediate gratification, such as the pleasure of eating, relative to the much smaller emphasis put on delayed benefits, such as enjoying good health.[4,5] Drawing on prior work suggesting that the same decision errors that hurt people can be used instead to help them, we show how interventions applied from behavioral economics can be used to change health behaviors and specifically to reduce the rate of obesity.[6]

For this study, we designed 2 incentive-based approaches for losing weight that magnify the impact of incentives using insights from behavioral economics. The 2 interventions consisted of a lottery-based

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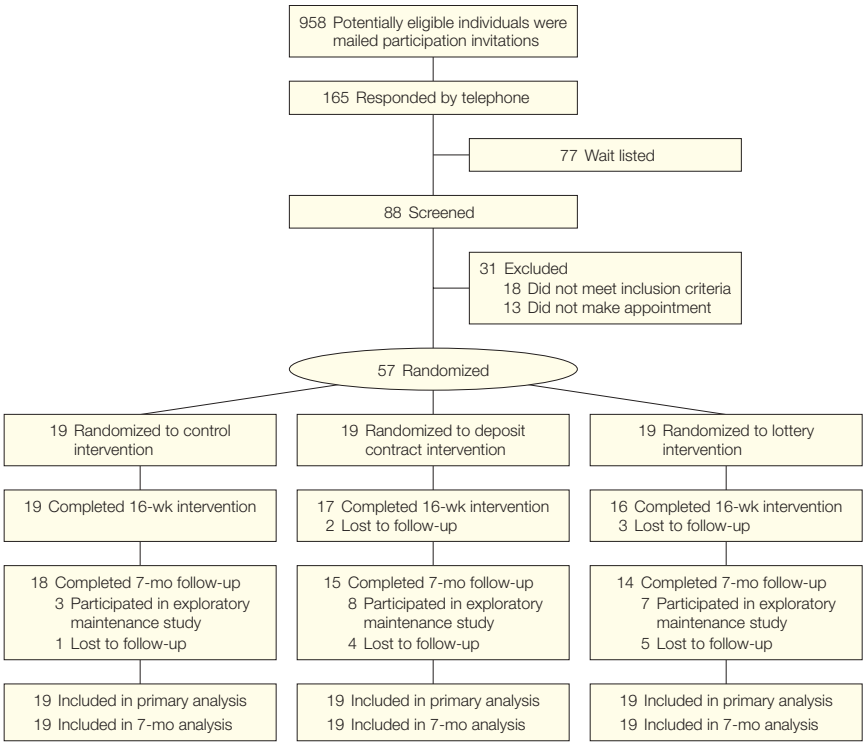
Figure 1. Flow of Study Participants



group in which participants played a lottery and received the earnings if they achieved or lost more than the target weight and a deposit contract condition in which participants invested their own money, which they lost if they failed to achieve weight goals. The effect of these incentives in achieving weight loss over a 16-week period was tested against a control group in a randomized controlled trial among obese and overweight study participants at the Philadelphia Veterans Affairs Medical Center.

METHODS

Study Population

The flow of participants through enrollment, intervention, and follow-up is shown in FIGURE 1. Participants meeting initial eligibility requirements were recruited using mailings. Those responding to the mailings were further screened for eligibility.

Eligible participants were between age 30 and 70 years (inclusive) and had a body mass index (BMI, calculated as weight in kilograms divided by height in meters squared) of 30 to 40 (inclusive). We used a minimum age of 30 years because a lower minimum age risks having too mixed a group from an intervention perspective, and the upper age was set at 70 years because the evidence for the benefit of weight reduction after age 70 years is relatively weaker than at younger ages.[7] We chose an upper limit on a BMI of 40 to minimize the influence of outliers on the main result of weight loss. Otherwise, the exclusion criteria were limited to those conditions that would make participation either infeasible (inability to consent, illiteracy, participation in another weight loss program) or unsafe (current treatment for drug or alcohol use, consumption of >5 alcoholic drinks per day, myocardial infarction or stroke within the past 6 months, current addiction to prescription medicines or street drugs, serious psychiatric diagnoses). Patients self-identified race or ethnicity selecting from a list on a questionnaire.

Randomization Procedures

Participants were randomized evenly to the 3 groups using a block size of 6, with stratification based on sex and age (30-49 years vs 50-70 years). Sealed envelopes generated by the statistician were used within each of the strata so that the research coordinator who enrolled the participants did not know the randomization assignment of the next participant until it had been assigned. Neither the participants nor the coordinator could be blinded to the randomization assignment given the nature of the intervention.

Study Protocol

The protocol was approved by the institutional review boards of the Philadelphia Veterans Affairs Medical Center and the University of Pennsylvania. All participants provided signed, written informed consent. Fifty-seven participants were randomly assigned to participate in either a weight-monitoring program involving monthly weigh-ins, or the same program with 1 of 2 financial incentive plans (deposit contract or lottery). At initial enrollment, participants had a 1-hour one-on-one consultation with a dietitian covering diet and exercise strategies for weight loss. All participants were given a free scale with precision to 0.2 lb (to convert to kilograms, multiply by 0.45).

Participants in incentive groups were given a chart at the initial visit depicting the daily weight goals they needed to attain to qualify for the incentives, with all participants having a goal weight loss of 16 lb over 16 weeks. Recruitment of participants began in May 2007 and ended in August 2007, with follow-up ending in June 2008.

Deposit contract financial incentive participants were given the opportunity to contribute between $0.01 and $3.00 for each day of the month that were refundable at the end of the month if they met or exceeded their weight loss goal. As an incentive for participants to contribute to deposit contracts, we matched their money 1:1 and added a fixed payment of $3 per day. Participants accumulated rewards each day

they called in and reported a weight at or below their weight loss goal and were provided with daily feedback via text message advising them of how much money they had earned that day. They were aware, however, that they would only receive accumulated awards if they weighed at or below their weight loss goal at the end of the month weigh-in. Thus, participants in the deposit contract group could earn as little as $0 or as much as $252 per month, depending on what they invested and how much weight they lost. Participants decided at the beginning of each month how much they wished to deposit for the next month.

Participants in the lottery incentive group were eligible for a daily lottery prize with an expected value of $3/d, but only if, prior to the lottery being resolved, they had reported a weight at or below their weight loss goal. The lottery provided infrequent large payoffs (a 1 in 100 chance at a $100 reward) and frequent small payoffs (a 1 in 5 chance at a $10 reward). Each lottery incentive participant chose a 2-digit number upon recruitment, eg, "27." A 2-digit number was randomly generated every day. If the first digit generated was a "2" or the last digit was a"7" (which has approximately a 1 in 5 chance) and the participant met his/her daily weight loss goal, he/she would win $10. If the randomly drawn number was "27" (a 1 in 100 chance), the person would win $100. Similar to the deposit contract group, those in the lottery group received daily feedback about each day's payoff via text message but only received accumulated payments if they were at or below their weight loss goal at the end of month weigh-in.

Both deposit contract and lottery incentive participants were instructed to weigh themselves each morning before eating or drinking and after urinating, record their weights, and call in their weight to the project staff by noon. Every day, they were sent a message via text pager indicating whether they were on track toward attaining their monthly weight loss goal and how much they had won that day in incentives. Participants who sent their early morning weights received rapid, same-day feedback about their progress and earnings, if any. Nonadherent participants received feedback about what their earnings would have been had they met their target weight.

Participants returned to the clinic at the end of each month to be weighed. Participants in the incentive groups received weight loss incentives if their weight on the clinic scale was at or below the target for that month. Participants in the deposit contract were asked how much they wanted to deposit for the subsequent month. To minimize loss to follow-up rates at monthly weigh-ins, all participants received $20 each time they attended a monthly weigh-in regardless of weight loss.

Deposit contract money that was forfeited by participants failing to lose a sufficient amount of weight was contributed to a pool of money that was divided equally among deposit contract participants who lost 20 lb or more over the 16 weeks ($46.25 per participant who lost at least 20 lb). In addition, all participants in the lottery and deposit contracts who lost more than 20 lb by the end of the 4 months received a bonus of $50.

A key feature of the weight loss trajectory is that it was reset at monthly intervals for those failing to attain goals. For those who had surpassed their weight loss goals, the weight loss trajectory was flattened; such individuals could then lose weight at a slower rate and still attain the final 16-lb weight loss goal. Participants whose weight was higher than their weight loss goal at the end of a month were given a "fresh start" in which the overall weight loss goal stayed the same but the slope of the trajectory was adjusted (ie, steepened) so that the participant need not "binge diet" to resume receiving incentive payments, which assumes the participant lost 2 lb instead of 4 lb in first month). This feature was important for reducing the likelihood of dropouts among participants who failed to lose sufficient weight during a particular month. Keeping the overall weight loss goal constant made the procedure fair for those participants who maintained the ideal trajectory while allowing participants who lapsed to get back on track more easily.

Study participants who lost at least 11 lb in the first 16 weeks of the study were given the option of participating in an exploratory follow-up study in which half of participants were randomly assigned to receive further incentives for maintenance of weight loss for the following 6 months. However, only 24 participants qualified for this intervention (4/19 in the control group, 10/19 in the deposit contract group, 10/19 in the lottery group), of those, 18 agreed to participate (3 in control group, 8 in deposit contract group, and 7 in lottery group). Those who did not participate in the maintenance phase were all scheduled to return to the office for a 7-month follow-up weigh-in. These weigh-ins were conducted at a median of 7 months and a mean of 8 months from the start of the study.

Statistical Analyses

Our primary outcome was weight loss after 16 weeks. We hypothesized that participants in each of the incentive groups would achieve significantly greater weight loss than control group participants. Primary analyses were intent-to-treat analyses, adjusted for baseline weight, testing for differences between each of the incentive and control groups in weight loss after 16 weeks using *F* tests. All participants lost to follow-up were treated as having their weight return to baseline. Because testing differences in the primary outcome between conditions entailed multiple comparisons, a reduced α level of .025 was used for these analyses. We report weight loss in pounds because all communication with study participants about weight loss goals was in pounds; furthermore, we thought it likely that our study population would be more familiar with pounds than a metric-based measure such as kilograms.

Unadjusted odds ratios (ORs) for the likelihood of reaching the 16-lb

weight loss goal were estimated and compared with ORs ratios adjusted for the stratification variables (sex and age) as well as other baseline covariates. The similarity of the treatment and control groups with respect to covariates at baseline was analyzed by Pearson χ^2 test for categorical variables and the *t* test or Wilcoxon rank sum for continuous variables, as appropriate.

Our secondary outcome was weight loss after 7 months, which was the median follow-up interval among those who did not participate in the maintenance phase. Relative to control participants, a greater proportion of the incentive participants was enrolled in the maintenance phase; however, the degree of weight regain was statistically similar in both the study participants who enrolled in the maintenance weight loss intervention and those who simply came in for follow-up weigh-ins. In our secondary, exploratory analyses, we therefore assessed average 7-month follow-up weight loss across the 3 conditions using 2-sided *t* tests to compare each incentive group with the control group as for the primary outcome. Because of the variation in timing of the planned follow-up visit, we also conducted this analysis using the mean follow-up time (8 months) rather than the median. All participants lost to follow-up were treated as having their weight return to baseline.

Our power calculations were based on finding a difference in weight loss of 11 lb at 16 weeks, which we viewed as a threshold for a clinically significant degree of weight loss in this population.[8,9] Making the assumption of an 11-lb standard deviation for weight loss and using a 2-sided α of .025, we required 19 participants per group to provide 80% power to find an 11-lb difference in weight loss between the groups. Because stratification by baseline weight was deemed infeasible in this relatively small population, analyses were adjusted for baseline weight in order to maintain comparability across groups.

All tests were 2-sided. We used SPSS v15.0 (SPSS Inc, Chicago, Illinois) to analyze the data.

RESULTS

No significant differences were found in the baseline characteristics of any of the groups (TABLE 1). The sample was predominantly male, with total household incomes of about $30 000, and a mean enrollment BMI of between 33.8 and 35.5 across the 3 groups. Participants in all 3 groups rated the importance of controlling their weight to be high on a 10-point scale (9.11-9.31) and had high confidence in their ability to lose weight (8.32-8.47).

Seventeen of 19 participants (89.5%) in deposit contract made initial deposits. Fourteen of those either held constant or increased their contributions each month. The average (SD) daily deposit contract contribution was $1.56 ($4.55); the median was $1.49 (interquartile range [IQR], $9.27).

The mean weight loss at 16 weeks was greater in each of the incentive

Table 1. Characteristics of the Study Sample[a]

Participant Characteristics	No./Total (%)			
	Entire Sample (n = 57)	Control (n = 19)	Deposit Contract (n = 19)	Lottery (n = 19)
Male sex	54/57 (94.7)	18/19 (94.7)	18/19 (94.7)	18/19 (94.7)
Race/ethnicity				
Black	23/56 (41.1)	9/18 (50.0)	5/19 (26.3)	9/19 (47.4)
White	30/56 (53.6)	8/18 (44.4)	13/19 (68.4)	9/19 (47.4)
Hispanic	1/56 (1.8)	1/18 (5.6)	0/19 (0)	0/19 (0)
American Indian or Alaskan Native	2/56 (3.6)	0/18 (0)	1/19 (5.3)	1/19 (5.3)
Married	32/57 (56.1)	11/19 (57.9)	11/19 (57.9)	10/19 (52.6)
Education				
≤Some high school	3/57 (5.3)	2/19 (10.5)	0/19 (0)	1/19 (5.3)
Completed high school or GED	16/57 (28.1)	4/19 (21.1)	7/19 (36.8)	5/19 (26.3)
≥Some college	38/57 (66.7)	13/19 (68.4)	12/19 (63.2)	13/19 (68.4)
Median total annual household income from all sources (25th-75th percentile), $	30 000 (15 000-54 675)	24 972 (11 625-43 000)	30 500 (17 000-65 000)	34 000 (15 250-58 012)
Height, mean (SD)	5′9″ (2.9)	5′9″ (3.3)	5′9″ (2.5)	5′9″ (3.1)
Initial weight measurements, mean (SD)				
Weight, lb	237.8 (28.9)	230.6 (31.4)	240.9 (24.9)	241.9 (30.1)
BMI	34.9 (2.6)	33.8 (2.3)	35.3 (2.6)	35.5 (2.7)
Self-rated importance of controlling weight measured on a 0-10 scale, mean (SD)	9.19 (1.3)	9.31 (1.5)	9.11 (.99)	9.16 (1.3)
Confidence in ability to lose weight measured on a 0-10 scale, mean (SD)	8.42 (1.6)	8.47 (1.9)	8.32 (1.2)	8.47 (1.6)

Abbreviations: BMI, body mass index, calculated as weight in kilograms divided by height in meters squared; GED, general education development.
Conversion factor: To convert from pounds to kilograms, multiply by 0.45; from feet to meters, multiply by 0.3; and inches to centimeters, multiply by 2.54.
[a]No significant differences were found between groups in any of these conditions.

groups: 13.1 lb for the lottery group ($F_{1,35}$=6.20; P=.02; 95% CI of the difference in means, 1.95-16.40), 14.0 lb for the deposit contract group ($F_{1,35}$=8.55; P=.006; 95% CI of the difference in means, 3.69-16.43) vs 3.9 lb for the control group (TABLE 2). Although only 10.5% (95% CI, 1.3%-33.1%) of control participants attained the 16-lb weight loss goal, about half of the incentive participants did: 52.6% (95% CI, 28.9%-75.6%) in the lottery group, 47.4% (95% CI, 24.5%-71.1%) in the deposit contract group (χ^2_2=8.59, P=.01). The odds of achieving the 16-lb weight loss goal were significantly greater in both the deposit (OR, 7.7; 95% CI, 1.4-42.7) and lottery (OR, 9.4; 95% CI, 1.7-52.7) groups compared with the control group (results not shown). Results were qualitatively similar after adjusting for the stratification variables of age and sex.

Exploratory subgroup analyses revealed qualitatively similar patterns regardless of age, income, or initial BMI. The only other significant predictor of weight loss was race. While whites lost significantly more weight than blacks (mean, 14.7 lb for whites; mean, 4.2 lb for blacks; t=3.57; P=.001; 95% CI of the difference in means, 4.6-16.4), adjusting for race did not affect the relative effectiveness of the incentive conditions. The racial composition did not differ significantly among conditions (Table 1).

The percentage of participants losing at least 20 lb was 36.8% (95% CI, 16.3%-61.6%) in the deposit contract group, 26.3% (95% CI, 9.2%-51.2%) in the lottery group, and 5.3% (95% CI, 0.1%-26.0%) in the control group (χ^2_2=5.58, P=.06). These participants each received a $50 bonus, and deposit contract participants who lost at least 20 lb each received an additional $46 (their share of the total amount forfeited by participants in their group who did not lose weight). All but 1 of the participants in the 2 incentive groups completed the study, with 33 of 38 having lost weight over 16 weeks.

Table 2. 16-Week Weight Loss Measures by Group

Measure	Control (n = 19)	Deposit Contract (n = 19)	Lottery (n = 19)
Total weight loss, lb			
Mean (SD)	3.9 (9.1)	14.0 (10.2)[a]	13.1 (12.6)[a]
95% CI	0.20-13.2	9.4-18.6	7.4-18.8
Met 16-lb weight loss goal,			
No./total (%)	2/19 (10.5)	9/19 (47.4)[a]	10/19 (52.6)[a]
95% CI	1.3-33.1	24.4-71.1	28.9-75.5
>20-lb loss			
No./total (%)	1/19 (5.3)	7/19 (36.8)[a]	5/19 (26.3)[a]
95% CI, %	0.1-26.0	16.3-61.6	9.2-51.2

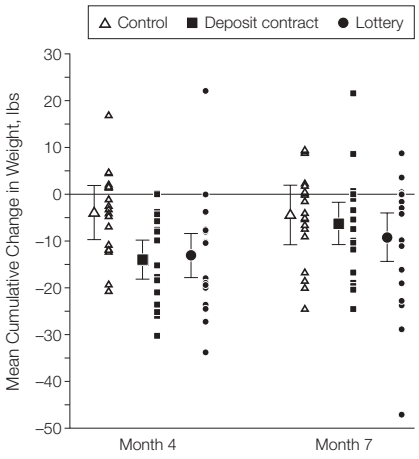
Abbreviation: CI, confidence interval.
Conversion factor: To convert pounds to kilograms, multiply by 0.45.
[a] Difference between incentive and control conditions significant at $P \leq .05$.

Over the course of the 16-week study, the average amount of money earned in weight loss incentives was $378.49 in the deposit contract condition and $272.80 in the lottery condition.

Of those who completed the study, the daily call-in rate was extremely high and not statistically different between incentive conditions: 94.0% for the deposit contract group; 97.4% for the lottery group ($F_{2,43}$; P=.13, 95% CI of the difference in means, –8% to 1%). There were no significant adverse events related to the study in either of the intervention groups.

Study participants in both the lottery and deposit contract groups gained weight between the end of the weight loss incentive intervention and the end of 7 months (FIGURE 2). Although the net weight loss between enrollment in the study and the end of 7 months was larger in the incentive groups (9.2 lb for the lottery group; 6.2 lb for the deposit contract group) than in the control group (4.4 lb), these differences were not statistically significant (t=1.21; P=.23; 95% CI, –3.20 to 12.66 lb for the lottery group; t=0.52; P=.61; 95% CI, –5.17 to 8.75 lb for the deposit contract group). At the end of 7 months, however, lottery and deposit contract participants weighed significantly less than they did at the beginning of the study (t_{18}=–2.87, P=.01; 95% CI, –15.89 to –2.47 for the lottery group; t_{18}=–2.41; P=.03; 95% CI, –11.67 to –0.81 for the deposit contract group), whereas control participants did not (t_{18}=–1.97; P=.06, 95% CI, –9.19 to 0.29). At 8 months, weight among deposit contract participants was less than at baseline to only a marginally significant degree (P =.10); otherwise, follow-up results of maintenance participants at the end of 8 months were qualitatively similar.

Figure 2. Weight Loss From Enrollment Through Intervention and 7-Month Follow-up



Participants in each group regained weight following the conclusion of the intervention. At 4 months, those in the incentive groups lost significantly more weight than those in the control group (P=.02 in the lottery group and P=.006 in the deposit contract group), but at the 7-month follow-up after enrollment, the weight difference between groups was no longer statistically significant (P=.23 for the lottery group and P=.61 in the deposit contract group). Nevertheless, those in the incentive groups experienced a net loss between enrollment and at the 7-month interval, whereas those in the control group did not. Error bars indicate 95% confidence intervals.

COMMENT

This study demonstrates the effectiveness of incentive systems based on behavioral economics in promoting weight loss. Lost to follow-up rates were much lower than is typical in weight loss studies, suggesting that this approach was successful in keeping participants engaged, and significant weight loss was achieved without coupling the incentive program with an intensive, expensive weight loss program. Weight loss of the magnitudes obtained in the incentive conditions has been shown to improve immediate outcomes such as blood pressure, glycemic control, and serum lipid levels, and a mean weight loss of 5.5 kg (12.2 lb) has been associated with a reduction in the incidence of diabetes of 58% over an average follow-up interval of 2.8 years.[8,9] However, substantial amounts of weight were regained between the end of the weight loss phase and the follow-up 3 months later. A key challenge in weight loss interventions is to both attain initial weight loss and to maintain that weight loss over periods of 12 months or more.[10] Further testing of longer-term use of these incentives is needed to determine whether longer use would lead to sustained weight loss.

Our work expands understanding of how financial incentives can contribute to weight loss. In a recent study, Finkelstein and colleagues found that over a 3-month period participants offered $14 per percentage point of weight loss lost 4.7 pounds and participants offered $7 per percentage point of weight loss lost 3.0 lb compared with 2.0 lb among control group participants.[11] Jeffrey and colleagues[12,13] had earlier demonstrated that significant weight loss could be achieved using deposit contracts, but these studies had required substantial upfront payments and the incentive programs were tied to intensive weight loss programs. The large upfront payments (equivalent to about $800 in today's dollars) led to about 15% of potential participants responding to invitations to join the Jeffrey study in contrast with 81.4% in this study. Incentive-based approaches that involve applying incentives to participants rather than physicians have great potential to change participant health behaviors.[6,14-18] This is important because unhealthful behaviors such as smoking, poor diet, and sedentary lifestyles may account for as much as 40% of premature mortality in the United States,[18] whereas deficiencies in health care delivery may account for only 10% of premature mortality.[19]

The interventions in this study were designed to take advantage of several effects identified in the behavioral economics literature, many of which have not been tested in previous incentive studies. First, consistent with research showing that even small rewards and punishments can have great incentive value if they occur immediately,[20-23] participants received rapid feedback about whether they won and nonadherent participants received feedback about whether they would have won had they been adherent.

Second, based on research showing that people are motivated by the experience of past rewards and the prospect of future rewards[24] and that people are particularly emotionally attracted to small probabilities of large rewards,[25] the lottery provided frequent small payoffs (a 1 in 5 chance at a $10 reward) and infrequent large payoffs (a 1 in 100 chance at a $100 reward).

Third, research on decision making has found that the desire to avoid regret is a potent force in decision making under risk,[26] so by giving participants who did not lose weight feedback about what they would have won had they been adherent, the incentive scheme maximized the anticipated threat of regret by people who fail to adhere. Anticipated regret has been shown to affect a variety of preventive behaviors, such as the significant increase in vaccination use among people who experienced illness after failing to get vaccinated.[27] Lotteries also provide variable reinforcement, an approach known to be especially effective in reinforcing behavior.[28] The use of deposit contracts is a powerful mechanism for inducing behavior change that is based on *loss aversion*, a psychological concept first described by Nobel Prize winner Daniel Kahneman and Amos Tversky[29] in 1979. Loss aversion has been used to explain many inconsistencies in traditional economic choice models, including anomalous patterns of choice under conditions of uncertainty.[30,31] Critical to using loss aversion to motivate behavior is the concept of decision isolation; people react so powerfully to small losses and gains in part because they consider them in isolation and fail to integrate them psychologically with the often much larger fluctuations in income arising from work-earnings and investments.[32,33]

An important outstanding question is the relative cost-effectiveness of different approaches to achieving sustained weight loss, because maintenance of successful weight loss has been a big challenge in all weight loss programs.[34,35] This has taken on increasing urgency because of markedly increasing rates of obesity within the US population.[2,36,37] Many behavioral interventions and pharmacotherapy are costly and generally have produced weight loss in studies of 6 to 12 month's follow-up of only 3 kg to 5 kg.[34] Surgical treatment, while effective in inducing weight loss in morbidly obese participants, has a relatively high rate of complications and high costs.[38]

This study was limited to veterans at a single facility and had a low percentage of women. It is unknown how the effectiveness of this type of program might differ in men and women. Because the study population consisted of patients who volunteered to participate, study participants were likely more motivated than the average obese patient. We also have only limited data on the sustainability of the intervention and longer-term follow-up would be useful. The persistence of weight loss following withdrawal of longer-term incentives is also an important question for further research. In addition, daily feedback was an intrinsic part of the incentive interventions, and we cannot

determine the independent impact of the feedback alone. However, feedback alone would constitute a relatively weak intervention which in itself would seem unlikely to produce significant weight loss. Study staff could not be blinded because of the nature of the intervention. Finally, while conducted as a randomized trial with adequate power, the study was small and these concepts should be tested in a multicenter randomized trial that includes examination of sustainability and different incentive program designs.

In conclusion, incentive approaches based on behavioral economic concepts appear to be highly effective in inducing initial weight loss. However, this weight loss was not fully sustained and further work is needed to test the effectiveness and cost-effectiveness of these approaches in achieving sustained weight loss.

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Author Contributions: Dr Volpp had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Volpp, Loewenstein.
Acquisition of data: Volpp, John, Norton, Fassbender
Analysis and interpretation of data: Volpp, John, Troxel, Loewenstein.
Drafting of the manuscript: Volpp, John, Loewenstein.
Critical revision of the manuscript for important intellectual content: Volpp, John, Troxel, Norton, Fassbender, Loewenstein.
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